

I. *Experiments and Observations, tending to illustrate the Nature and Properties of Electricity : By William Watson, Apothecary, F. R. S.*

A Letter to Martin Folkes, Esq; Pr. R. S.

S I R,

Read at several Meetings of the Royal Society, between March 28, and October 24, 1745. here printed with Alterations.

I. **T**HE SOCIETY having heard, from some of their Correspondents in * *Germany*, that what they call a Vegetable Quintessence had been fired by Electricity, I take this Opportunity to acquaint you, that, on *Friday* Evening last, I succeeded, after having been disappointed in many Attempts, in setting Spirits of Wine on fire by that Power.

The preceding Part of the Week had been remarkably warm, and the Air very dry ; than which nothing is more necessary towards the Success of electrical Trials: To these I may add, that the Wind was then Easterly, and inclining to freeze. I that Evening used a glass Sphere, as well as a Tube ; but I always find myself capable of sending forth much more Fire from the Tube than from the Sphere, probably, from not being sufficiently used to the last.

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* See an Account of Prof. *Winckler's* Book of *Electricity* in these *Transf.* N^o. 474. p. 166. Prof. *Hollman, Transf.* N^o. 475. p. 239. Dr. *Miles, ib.* p. 290. *Winckler's* Experiments, *ib.* p. 307. Mr. *de Bozes, Transf.* N^o. 475. p. 419. C. M.

I had before observ'd, that, altho' * Non-electric Bodies, made electrical, lose almost all that Electricity, by coming either within or near the Contact of *Non-electrics* not made electrical. It happens otherwise with regard to *Electrics per se*, when excited by rubbing, patting, &c. ; because from the rubbed Tube I can sometimes procure five or six Flashes from different Parts ; as though the Tube of two Feet long, instead of being one continued Cylinder, consisted of five or six separate Segments of Cylinders, each of which gave out its Electricity at a different Explosion.

The Knowledge of this Theorem is of the utmost Consequence towards the Success of electrical Experiments ; inasmuch as you must endeavour, by all possible means, to collect the Whole of this Fire at the same time. Professor *Hollman* seems to have endeavour'd at this, and succeeded, by having a tin Tube ; in one End of which he put a great many Threads, whose Extremities touch'd the Sphere when in Motion, and each Thread collected a Quantity of electrical Fire, the Whole of which center'd in the tin Tube, and went off at the other Extremity. Another thing to be observed is, to endeavour to make the Flashes follow each other so fast, as that a
second

* I call *Electrics per se*, or originally *Electrics*, those Bodies, in which an attractive Power towards light Substances is easily excited by Friction ; such as Glass, Amber, Sulphur, Sealing-wax, and most dry Parts of Animals, as Silk, Hair, and such-like. I call *Non-electrics*, or Conductors of Electricity, those Bodies, in which the above Property is not at all, or very slightly perceptible ; such as Wood, Animals living or dead, Metals, and vegetable Substances. See *Gray, Du Fay, Desaguliers, Wheler*, in the *Philosophical Transactions*, N^o. 417. 422. 423. 431. 436. 439. 444. 453. 454. 460. 462. 464.

second may be visible before the first is extinguish'd. When you transmit the electrical Fire along a Sword, or other Instrument, whose Point is sharp, it often appears as a Number of disseminated Sparks, like wet Gunpowder or Wild-fire: But if the Instrument has no Point, you generally perceive a pure bright Flame, like what is vulgarly call'd the *Blue ball*, which gives the Appearance of Stars to fired Rockets.

The following is the Method I made use of, and was happy enough to succeed in. I suspended a Poker in silk Lines; at the Handle of which I hung several little Bundles of white Thread, the Extremities of which were about a Foot at right Angles from the Poker. Among these Threads, which were all attracted by the rubbed Tube, I excited the greatest electrical Fire I was capable, whilst an Assistant, near the End of the Poker, held in his Hand a Spoon, in which were the warm Spirits. Thus the Thread communicated the Electricity to the Poker, and the Spirit was fired at the other End. It must be observ'd in this Experiment, that the Spoon with the Spirit must not touch the Poker; if it does, the Electricity, without any Flashing, is communicated to the Spoon, and to the Assistant in whose Hand it is held, and so is lost in the Floor.

By these means I fired several times not only the ethereal Liquor or *Phlogiston* of *Frobenius*, and rectified Spirit of Wine, but even common proof Spirit. These Experiments, as I before observed, were made last *Friday* Night, the Air being perfectly dry. *Sunday* proved wet, and *Monday* somewhat warm; so that the Air was full of Vapour, Wind South-west, and

cloudy. Under these Disadvantages, on *Monday* Night I attempted again my Experiments ; they succeeded, but with infinitely more Labour than the preceding, because of the Unfitness of the Evening for such Trials. Your Candour will not permit you to think my Minuteness trivial, with regard to the Circumstances of the Weather, who know how many Things must concur to make these Experiments succeed. I shall wait with Impatience for a proper Opportunity to have these Experiments repeated in your Presence ; and am, with the utmost Respect,

S I R,

Aldersgate-Street, March 27.

1745.

Your most obedient

Humble Servant,

W. Watfon.

II.

A Letter to the ROYAL SOCIETY.

Gentlemen,

Read April 25. **I** Lately acquainted you, that I had been
1745. able to fire Spirit of Wine, *Phlogiston* of *Frobenius*, and common proof Spirit, by the Power of Electricity. Since which (till Yesterday) we have had but one very dry fine Day ; *viz. Monday, April 15.* Wind E. N. E. ; when, about Four o' Clock in the Afternoon, I got my *Apparatus* ready, and fired the Spirit of Wine four times from the Poker as before, three times from the Finger of a Person electrified, standing upon a Cake of Wax,
and

and once from the Finger of a second Person standing upon Wax, communicating with the first by means of a Walking-cane held between their Arms extended. The horizontal Distance in this Case between the glass Tube and the Spirit was at least ten Feet.

You all know, that there is the repulsive Power of Electricity, as well as the attractive; inasmuch as you are able, when a Feather, or such-like light Substance, is replete with Electricity, to drive it about a Room, which Way you please. This repulsive Power continues, until either the Tube loses its excited Force, or the Feather attracts the Moisture from the Air, or comes near to some non-electric Substance; if so, the Feather is attracted by, and its Electricity lost in, whatever Non-electric it comes near. In electrified Bodies, you see a perpetual Endeavour to get rid of their Electricity. This induced me to make the following Experiment.

I placed a Man upon a Cake of Wax, who held in one of his Hands a Spoon with the warm Spirits, and in the other a Poker with the Thread. I rubbed the Tube amongst the Thread, and electrified him as before. I then ordered a Person not electrified to bring his Finger near the Middle of the Spoon; upon which, the Flash from the Spoon and Spirit was violent enough to fire the Spirit. This Experiment I then repeated three times.

In this Method, the Person by whose Finger the Spirit of Wine is fired, feels the Stroke much more violent, than when the electrical Fire goes from him to the Spoon. This Way, for the sake of Distinction, we will call the repulsive Power of Electricity.

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The late Dr. *Desaguliers* has observed, in his excellent Dissertation concerning Electricity, ‘ That
 ‘ there is a sort of Capriciousness attending these
 ‘ Experiments, or something unaccountable in their
 ‘ *Phænomena*, not to be reduced to any Rule. For
 ‘ sometimes an Experiment, which has been made
 ‘ several times successively, will all at once fail.’
 Now I imagine, that the greatest Part, if not the
 Whole of this Matter, depends upon the Moisture
 or Dryness of the Air; a sudden though slight Al-
 teration in which, perhaps not sufficient to be obvious
 to our Faculties, may be perceived by the very sub-
 tle Fire of Electricity. For,

1st, I conceive, that the Air itself (as has been
 observed by Dr. *Desaguliers*) is an Electric *per se*,
 and of the vitreous Kind; therefore it repels the
 Electricity arising from the glass Tube, and disposes
 it to electrify whatever non-electrical Bodies receive
 the *Effluvia* from the Tube.

2dly, That Water is a Non-electric, and, of con-
 sequence, a Conductor of Electricity. This is exem-
 plified by a Jet of Water being attracted by the Tube,
 from either Electrics *per se* conducting Electricity,
 and Non-electrics more readily when wetted; but
 what is more to my present Purpose, is, that if you only
 blow through a dry glass Tube, the Moisture from
 your Breath will cause that Tube to be a Conductor
 of Electricity.

These being premised, in proportion as the Air is
 replete with watery Vapours, the Electricity arising
 from the Tube, instead of being conducted, as pro-
 posed, is, by means of these Vapours, communicated

to the circumambient Atmosphere, and dissipated as fast as excited.

This Theory has been confirmed to me by divers Experiments, but by none more remarkably than on the Evening of the Day I made those before-mention'd; when the Vapours, which in the Afternoon, by the Sun's Heat, and a brisk Gale, were dissipated, and the Air perfectly dry, descended again in great Plenty, upon the Absence of both, and in the Evening was very damp. For between seven and eight o' Clock, I attempted again the same Experiments in the same manner, without being able to make any of them succeed; though all those mentioned in this Paper, with others of less Note, were made in less than half an Hour's time.

I am the more particular in this, being willing to save the Labour of those, who are desirous of making this Kind of Trials. For, although some of the lesser Experiments may succeed almost at any time, yet I never could find, that the more remarkable ones would succeed but in dry Weather. I am,

Gentlemen,

Your most obedient,

London, April 25.

1745.

Humble Servant,

W. Watson.

III.

*A Letter to the ROYAL SOCIETY.**Gentlemen,*Read Octob. 24.
1745.

IN some Papers I lately did myself the Honour to lay before you, I acquainted you of some Experiments in Electricity; particularly I took notice of having been able to fire Spirit of Wine by what I called the repulsive Power thereof; which I have not heard had been thought of by any of those *German* Gentlemen, to whom the World is obliged for many surprising Discoveries in this Part of Natural Philosophy.

How far, strictly speaking, the Spirit, in this Operation, may be said to be fired by the repulsive Power of Electricity, or how far that Power, which repels light Substances when fully impregnated with Electricity, fires the Spirit, may probably be the Subject of a future Inquiry; but, as I am unwilling to introduce more Terms into any Demonstration than what are absolutely necessary for the more ready Conception thereof, and as inflammable Substances may be fired by Electricity two different Ways, let the following Definitions at present suffice of each of these Methods.

But first give me Leave to premise, that no inflammable Substances will take Fire, when brought into or near the Contact of Electrics *per se* excited to Electricity. This Effect must be produced by non-electrical Substances impregnated with Electricity received from the exciting Electrics *per se*. But to return:

1st,

1st, I suppose that inflammable Substances are fired by the attractive Power of Electricity, when this Effect arises from their being brought near excited Non-electrics.

2^{dly}, That inflammable Substances are fired by the repulsive Power of Electricity; when it happens, that the inflammable Substances, being first electrified themselves, are fired by being brought near Non-electrics not excited.

This Matter will be better illustrated by an Example. Suppose that either a Man standing upon a Cake of Wax, or a Sword suspended in silk Lines, are electrified, and the Spirit, being brought near them, is fired, this is said to be performed by the attractive Power of Electricity. But if the Man electrified, as before, holds a Spoon in his Hand containing the Spirit, or the same Spoon and Spirit are placed upon the Sword, and a Person not electrified applies his Finger near the Spoon, and the Spirit is fired from the Flame arising from the Spoon and Spirit upon such Application, this I call being fired by the repulsive Power. Of the two mention'd Kinds I generally find the repulsive Power strongest.

Since my last Communication, the Spirit has been fired both by the attractive and repulsive Power thro' four Persons standing upon electrical Cakes, each communicating with the other, either by the Means of a Walking-cane, a Sword, or any other non-electric Substance. It has likewise been fired from the Handle of a Sword held in the Hand of a third Person.

I have not only fired *Frobenius's Phlogiston*, rectified Spirit, and common proof Spirit, but also *Sal*

volatile oleofum, Spirit of Lavender, dulcified Spirit of Nitre, Peony-water, *Daffy's* Elixir, *Helvetius's* Styptic, and some other Mixtures where the Spirit has been very considerably diluted; likewise distilled vegetable Oils, such as that of Turpentine, Lemon, Orange-peels, and Juniper; and even those of them which are specifically heavier than Water, as Oil of Sassafras; also resinous Substances, such as Balsam *Cappivi*, and Turpentine; all which send forth, when warmed, an inflammable Vapour. But expressed vegetable Oils, as those of Olives, Linseed, and Almonds, as well as Tallow, all whose Vapours are un-inflammable, I have not been able yet to fire; but these indeed will not fire on the Application of lighted Paper. Besides, if these last would fire with lighted Paper, unless their Vapours were inflammable, I can scarce conceive they would fire by Electricity; because, in firing Spirits, &c. I always perceive, that the Electricity snaps, before it comes in Contact with their Surfaces, and therefore only fires their inflammable Vapours.

As an excited Non electric emits almost all its Fire, if once touch'd by a Non-electric not excited, I was desirous of being satisfy'd, whether or no the Fire emitted would not be greater or less in proportion to the Volume of the electrified Body. In order to this, I procured an iron Bar about 5 Feet long, and near 170 Pounds in Weight; this I electrified lying on Cakes of Wax and Resin, but observed the Flashes arising therefrom not more violent than those from a common Poker. In making this Experiment, being willing to try the repulsive Force, it once happen'd, that whilst the Bar was at one End electrifying,
a Spoon

a Spoon lay upon the other ; and, upon an Assistant's pouring some warm Spirit into the Spoon, the electrical Flash from the Spoon snapped, and fired the first Drop of the Spirit ; which unexpectedly fired not only the whole Jett as it was pouring, but kindled likewise the whole Quantity in the Pot, in which I usually have it warm'd.

I find, in firing inflammable Substances from the Finger of a Man standing upon Wax, that, *ceteris paribus*, the Success is more constant, if the Man, instead of holding the Thread (the Use of which I communicated in a former Paper) in his Hand, the Thread is suspended at the End of an iron Rod held in one Hand, and he touches the Spirit with one of the Fingers of the other.

If a Man, standing upon the electrical Cake with a Dish or deep Plate of Water in one Hand, and the iron Rod with the Thread in the other, is made electrical, and a Person not electrified touches any Part either of the Plate or Water, the Flashes of Fire come out plentifully ; and where-ever you bring your Finger very near, the Water rises up in a little Cone, from the Point of which the Fire is produced, and your Finger, though not in actual Contact, is made wet. The same Experiment succeeds through three or more People.

In firing inflammable Substances, the Person who holds the Spoon in his Hand to receive the electrical Flashes, when the Finger of the electrified Person is brought near thereto, not only feels a Tingling in his Hand, but even a slight Pain up to his Elbow. This is most perceptible in dry Weather, when the Electricity is very powerful.

There is considerable Difficulty in firing Electrics *per se*, such as Turpentine and Balsam *Capivi*, by the repulsive Power of Electricity; because, in this Case, these Substances will not permit the Electricity to pass through them: Therefore, when you would have this Experiment succeed, the Finger of the Person who is to fire them, is to be applied as near to the Edge as possible of these Substances when warmed in a Spoon, that the Flashes from the Spoon (for these Substances will emit none) may snap, where they are spread the thinnest, and then fire their *Effluvia*. This Experiment, as well as several others, serves to confute that Opinion, which has prevailed with many, that the Electricity floats only upon the Surfaces of Bodies.

If an electrical Cake is dipp'd in Water, it is thereby made a Conductor of Electricity; the Water hanging about it transmitting the electrical *Effluvia* in such a manner, that a Person standing thereon can by no means be electrified enough to attract the Leaf Gold at the smallest Distance; though the Person standing upon the same Cake when dry, attracted a Piece of fine Thread hanging at the Distance of two Feet from his Finger. We must here observe, that the Cake being of an unctuous Substance, the Water will no-where lie uniformly thereon, but adhere in separate *Molecule*; so that, in this Instance, the Electricity jumps from one Particle of Water to another, till the Whole is dissipated.

From the Appearance of the Threads, amongst which I rub the Tube, I can frequently judge, though the Spirit may be many Feet distant from them, whether or no it will fire; because, when the Persons

sons standing upon the Wax are made electrical enough to fire the Spirit, the Threads repel each other at their lower Parts, where they are not confin'd, to a considerable Distance; and this Distance is in Proportion as the Threads are made electrical.

If two Persons stand upon electrical Cakes at about a Yard's Distance from each other, one of which Persons, for the sake of Distinction, we will call *A*, the other *B*; if *A*, when electrified, touches *B*, *A* loses almost all his Electricity at that Touch only, which is received by *B*, and stopped by the electrical Cake: If *A* is immediately electrified again to the same Degree as before, and touches *B*, the Snapping is less upon the Touch; and this Snapping, upon electrifying *A*, grows less and less, till *B*, being impregnated with Electricity, though received at Intervals, the Snapping will no longer be sensible.

That Glass will repel and not conduct the Electricity of Glass, has been mention'd by others, who have treated of this Subject; but the Experiments to determine this Matter must be conducted with a great deal of Caution; for, unless the glass Tube, intended to conduct the Electricity, be as warm as the external Air, it will seem to prove the contrary, unless in very dry Places and Seasons. Thus I sometimes have brought a cold though dry glass Tube near three Feet long into a Room where there has been a Number of People; when, upon placing the Tube upon silk Lines, and laying some Leaf-Silver upon a Card at one End, and rubbing another glass Tube at the other, the Silver has, contrary to Expectation, been thrown off as readily as from an iron Rod. At first I was surpris'd at this Appearance;

ance; but then conjectur'd, that it must arise from the Coldness of the Glass, condensing the floating Vapour of the Room. In order then to obviate this, I warm'd the Tube sufficiently, and this Effect was no longer produc'd, but the Silver lay perfectly still.

If a Number of Pieces of finely spun Glass, cut to about an Inch in Length, little Bits of fine Wire of the same Length, of what Metal you please, and small Cork-Balls, are either put all together, or each by themselves, into a dry pewter Plate, or upon a Piece of polished Metal, they make, in the following Manner, a very odd and surprising Appearance. Let a Man, standing upon electrical Cakes, hold this Plate in his Hand, with the Bits of Glass, Wire, &c. detached from each other, as much as conveniently may be; when he is electrified, let him cause a Person standing upon the Ground to bring another Plate, his Hand, or any other Non-electric, exactly over the Plate, containing these Bodies. When his Hand, &c. is about eight Inches over them, let him bring it down gently: As it comes near, in proportion to the Strength of the Electricity, he will observe the Bits of Glass first raise themselves upright; and then, if he brings his Hand nearer, dart directly up, and stick to it without snapping. The Bits of Wire will fly up likewise, and as they come near the Hand snap aloud; you feel a smart Stroke, and see the Fire arising from them to the Hand at every Stroke: Each of these, as soon as they have discharged their Fire, falls down again upon the Plate. The Cork-Balls also fly up, and strike your Hand, but fall again directly. You have a constant Succession of these Appearances, as long as you continue

nue to electrify the Man in whose Hand the Plate is held ; but if you touch any Part either of the Man or Plate, the Pieces of Glas, which before were upon their Ends, immediately fall down.

Some few Years ago, Sir *James Lowther** brought some Bladders fill'd with inflammable Air, collected from his Coal-mines, to the *Royal Society*. This Air flamed, upon a lighted Candle being brought near it. This Inflammability has occasion'd many terrible Accidents. Mr. *Maud*, a worthy Member of this *Society*, made at that time, by Art, and shew'd the *Society*, Air exactly of the same Quality. I was desirous of knowing if this Air would be kindled by electrical Flashes. I accordingly made such Air, by putting an Ounce of Filings of Iron, an Ounce of Oil of Vitriol, and four Ounces of Water, into a *Florence* Flask ; upon which an Ebullition ensued, and the Air, which arose from these Materials, not only fill'd three Bladders, but also, upon the Application of the Finger of an electrified Person, took Flame, and burnt near the Top and out of the Neck of the Flask a considerable Time. When the Flame is almost out, shake the Flask, and the Flame revives. You must, with your Finger dipped in Water, moisten the Mouth of the Flask as fast as it is dried by the Heat within, or the Electricity will not fire it : Because the Flask, being an Electric *per se*, will not snap at the Application of the Finger, without the Glas being first made non-electric by wetting. It has sometimes happen'd, if the Finger has been applied before the inflammable Air has found a ready *Exit* from the Mouth of the Flask, that the Flask has
filled

* See these *Transf.* N^o. 442. p. 282.

filled the Flask, and gone off with an Explosion equal to the Firing of a large Pistol; and sometimes indeed it has burst the Flask. The same Effect is produced from Spirit of Sea Salt, as from Oil of Vitriol; but as the Acid of Sea-Salt is much lighter than that of Vitriol, there is no Necessity to add the Water in this Experiment.

Those who are not much acquainted with Chemical Philosophy, may think it very extraordinary, that, from a Mixture of cold Substances, which, both conjunctly and separately, are unflammable, this very inflammable Vapour should be produced. In order to solve this, it may not be improper to premise, that Iron is compounded of a sulphureous as well as a metallic Part. This Sulphur is so fixed, that, after heating the Iron red hot, and even melting it ever so often, the Sulphur will not be disengaged therefrom: But, upon the Mixture of the vitriolic Acid, and by the Heat and Ebullition which are almost instantly produced, the metallic Part is dissolved, and the Sulphur, which before was intimately connected therewith, being disengaged, becomes volatile. This Heat and Ebullition continue, till the vitriolic Acid is perfectly saturated with the metallic Part of the Iron; and the Vapour, once fired, continues to flame, until, this Saturation being perfected, no more of the Sulphur flies off.

I have heretofore mentioned, how considerably perfectly dry Air conduces to the Success of these Experiments; but we have been lately informed, by an Extract of a Letter, that Abbé *Nolet* was of Opinion, that they would succeed in wet Weather, provided the Tubes were made of Glass tinged blue with Zaffer. I have procured Tubes of this sort, but,
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after giving them many candid Trials, I cannot think them equal to their Recommendation. I first tried one of them in a smart Shower of Rain after a dry Day, when the Drops were large, and the Spirit fired three times in about four Minutes : The same Effect succeeded, under the same Circumstances, from the white one ; but, after three or four Hours raining, when the Air was perfectly wet, I never could make it succeed. And, to illustrate this Matter further, I have been able, when the Weather has been very dry, with once rubbing my Hand down this blue Tube, and applying it to the End of an iron Rod six Feet long, to throw off several Pieces of Leaf-Silver lying upon a Card at the other End of this Rod ; whereas I never have been able to throw it off by any means in very wet Weather. Besides, I am of Opinion, that, after the electrical Fire is gone from the Tube, the Tube has no Share in the conducting of it : My Sentiments on that Head I laid before you in a former Paper : For if the silk Lines are wetted, they diffuse all the Electricity ; and the same Effects happen, when the Air is wet, be your Glass of what Colour it will.

It may not be improper here to observe, that Zaffer, which is used by the Glass-makers and Enamellers, is made of Cobalt or Mundick calcined after the subliming the Flowers. This being reduced to a very fine Powder, and mixt with twice or thrice its own Weight of finely powder'd Flints, is moistened with Water, and put up in Barrels, in which it soon runs into an hard Mass, and is called Zaffer.

A dry Sponge hanging by a Packthread at the End of an electrified Sword, or from the Hand of an
Sff
electrified

electrified Man, gives no Signs of being made electrical: If it is well soak'd in Water, where-ever it is touch'd, you both see and feel the electrical Sparks. Not only so, but, if it is so full of Water that it falls from the Sponge, those Drops in a dark Room, receiv'd upon your Hand, not only flash and snap, but you perceive a pricking Pain. If you hold your Hand, or any non-electrical Substances, very near, the Water, which had ceased dropping when the Sponge was not electrified, drops again upon its being electrified; and the Drops fall in Proportion to the receiv'd Electricity, as though the Sponge were gently squeez'd between your Fingers. I was desirous to know if I was able to electrify a Drop of cold Water, dropping from the Sponge, enough to fire the Spirit; but, after many unsuccessful Trials, I was forced to desist; because the cold Water dropping from the Sponge not only cool'd the Spirit too much, but also render'd it too weak: Likewise every Drop carried with it great Part of the Electricity from the Sponge.

I then consider'd, in what manner I could give a Tenacity to the Water sufficient to make the Drops hang a considerable Time; and this I brought about by making a Mucilage of the Seeds of Fleawort. A wet Sponge then, squeez'd hard, and fill'd with this cold Mucilage, was held in the Hand of an electrified Man, when the Drops, forced out by the Electricity, assisted by the Tenacity of the Liquor, hung some Inches from the Sponge; and, by a Drop of this, I fired not only the Spirit of Wine, but likewise the inflammable Air before-mentioned, both with and without the Explosion. What an extraordinary

ordinary Effect is this, That a Drop of cold Water (for the Seeds contribute nothing, but add Consistence to the Water) should be the *Medium* of Fire and Flame ?

Camphor is a vegetable Resin, and, of consequence, an Electric *per se*. This Substance, notwithstanding its great Inflammability, will not take Fire from the Finger of a Man, or any other Body electrified, tho' made very warm, and the Vapours arise therefrom in great Abundance ; because, neither Electrics *per se* excited, or electrified Bodies, exert their Force by snapping upon Electrics *per se*, though not excited. If you break Camphor small, and warm it in a Spoon, it is not melted by Heat like other Resins ; but, if that Heat were continued, it would all prove volatile. To Camphor thus warm'd, the Finger of an electrified Man, a Sword, or such-like, will, in snapping, exert its Force upon the Spoon, and the circumambient Vapour of the Camphor will be fired thereby, and light up the whole Quantity exposed. The same Experiment succeeds by the repulsive Power of Electricity.

A Poker, thoroughly ignited, put into Spirit of Wine, or into the distilled Oil of Vegetables, produces no Flame in either. It indeed occasions the Vapours to arise from the Oil in great Abundance ; but if you electrify this heated Poker, the electrical Flashes presently kindle Flame in either. The Experiment is the same with Camphor. These Experiments, as well as the following, sufficiently evince, that the electrical Fire is truly Flame, and that extremely subtil.

I have made several Trials in order to fire Gunpowder alone, which I tried both warm and cold, whole and powder'd, but never could succeed: And this arises, in part, from its Vapours not being inflammable, and in part from its not being capable of being fir'd by Flame; unless the Sulphur in the Composition is nearly in the State of Accension. This we see, by putting Gunpowder into a Spoon with rectified Spirit, which, when lighted, will not fire the Powder, till, by the Heat of the Spoon from the burning Spirit, the Sulphur is almost melted. Likewise, if you hold Gunpowder ground very fine in a Spoon over a lighted Candle, or any other Flame, as soon as the Spoon is hot enough to melt the Sulphur, you see a blue Flame, and instantly the Powder flashes off. The same Effects are observed in the *Pulvis fulminans*, compos'd of Nitre, Sulphur, and fixed alkaline Salt. Besides, when the Gunpowder is very dry, and ground very fine, it (as you please to make the Experiment) is either attracted, or repell'd; so that, in the first Case, the End of your Finger, when electrified, shall be cover'd over with the Powder, though held at some Distance; and in the other, if you electrify the Powder, it will fly off at the Approach of any non-electrified Substance, and sometimes even without it. But I can, at Pleasure, fire Gunpowder, and even discharge a Musket, by the Power of Electricity, when the Gunpowder has been ground with a little Camphor, or with a few Drops of some inflammable chemical Oil. This Oil somewhat moistens the Powder, and prevents its flying away: The Gunpowder then being warm'd in a Spoon, the electrical
Flashes

Flashes fire the inflammable Vapour, which fires the Gun-powder: But the Time between the Vapour firing the Powder is so short, that frequently they appear as the same, and not successive Operations, wherein the Gun-powder itself seems fired by the Electricity: And, indeed, the first time this Experiment succeeded, the Flash was so sudden and unexpected, that the Hand of my Assistant, who touch'd the Spoon with his Finger, was considerably scorched. So that there seems a fourth Ingredient necessary to make Gun-powder readily take Fire by Flame; and That such a one as will heighten the Inflammability of the Sulphur.

In common Cases, the lighted Match, or the little Portion of red-hot Glass, which falls among the Powder, and is the Result of the Collision from the Flint and Steel, fires the Charcoal and Sulphur, and these the Nitre. But if to these three Ingredients you add a fourth, *viz.* a vegetable chemical Oil, and gently warm this Mixture, the Oil, by the Warmth, mixes intimately with the Sulphur, lowers its Consistence, and makes it readily take Fire by Flame.

In these Operations, notwithstanding I always made use of the finest-scented Oils of Orange peel, Lemons, and such-like, yet, upon the least warming the Mixture, the rank Smell of Balsam (*i. e.* of the ready Solution of Sulphur) was very obvious.